I. Introduction

Waterbirds occur on wetlands, often in spectacular concentrations, and are one of the most obvious indicators of the richness and diversity of these productive ecosystems It has been reported that about 20% of the threatened bird species in Asia inhabit wetlands. Various aspects such as status, distribution, migration, impact of climate etc. pertaining to waterbirds are widely researched all over the globe. But very little has been studied and published on the waterbirds and heronries of Kuttanad wetlands, southern portion of the Vembanad-Kol Ramsar site. No comprehensive studies have so far been carried out on the status of heronries and the ecology of Oriental Darter at the Kuttanad region. Hence, the present study on **'**the status and ecology of the near threatened Oriental Darter *Anhinga melanogaster* in the Kuttanad wetlands of Kerala**'** was carried out with the following objectives.

II. Objectives

- To document the status and distribution of the heronries in the Kuttanad wetlands
- To examine the breeding ecology of the Oriental Darter
- To assess the foraging ecology of the species
- Identify major plausible disturbances and threats to the population of this species and to suggest conservation measures

III. Materials and Methods

1. Study area

Kuttanad wetland is located in Kerala state at the Southwest coast of India and it is separated from the Arabian Sea by a narrow strip of land. This area is a highly complex, dynamic and unique rice growing wetland ecosystem of the state and is the "Rice Bowl" of Kerala and spreads over Kottayam, Alappuzha and Pathamthitta districts. This region lies between 9° 17' to 9° 40' N latitude and 76° 19' to 76° 33' E. Considerable portion of the Vembanad estuary is situated in Kuttanad wetland, which is the biggest estuary in the Southwest coast of India.

2. Methods

Regular surveys were carried out in the heronries to study the status of waterbirds during the breeding seasons. In each breeding colony, total number of active nests of each species, the number of young birds present, details of the location etc. were recorded during the three years (2009 – 2011) of the study period. Counts were taken once in two weeks. Conservation problems such as habitat alterations, hunting pressure, other human disturbances etc. were also noted. Nest tree parameters were collected during the study period at various heronries in randomly selected nesting trees. Nest tree species, height of the nesting tree, GBH, canopy cover, ground cover of the nesting tree, nest height, distance from path and nest success were collected and analyzed. Tree heights were calculated using the clinometers and hypsometer. Vegetation sampling was done using quadrate method for finding out the general vegetation of the nesting area. Foraging observation of the Darter was carried out only during the breeding season following 'focal animal sampling' (Altman, 1974). Feeding of the Darter was studied in five time schedule in a day. Feeding rate and rhythm were calculated. Diet of the Darters was studied using the direct observation method, sampling at foraging areas and from regurgitates at the nesting sites (Sutherland, 2004).

IV. Result

A total of 9,437 nests belonging to 11 species of colonial nesting waterbirds from 20 heronries were counted during the three years of study period. There found highly significant increase in the number of nests from 2009 to 2011. It was observed that the nesting of wetland birds started in May and lasted up to November. The peak nesting months in majority of the species were June and July. 11 species of waterbirds used to nest at the heronries of North Kuttanad, 4 species each in Kayal Lands, Lower Kuttanad and Upper Kuttanad divisions and two species only in Purakkadu Kari. Maximum species were found to nest in KTDC Tourist Complex – Kumarakom but only one species of waterbird nested in heronries of Nellanickal, Veliyam and Manipuzha. South Police Station – Alappuzha had maximum number of nests. Among the species Little Cormorant and Indian Pond-heron were the most wide spread breeder and they were found nesting in almost all heronries.

Oriental Darter was found to breed in 7 heronries. A total of 1,358 nests and 7552 nestlings of Oriental Darter were counted during the three years of study period. The population trends indicate that there is highly significant increase in the number of nests of Oriental Darter in Kuttanad wetland. Highest number of nests of Oriental Darter was found during 2011 (this was 3.89 % of the estimated world population and 32% of the South Asian Biogeographic population). Maximum number of nests in a single breeding season (2011 season) was recorded from Karumadi heronry in the lower Kuttanad division and lowest was from Chirayakom.

Little Cormorant was found to nest in 18 heronries and showed significant increase in the number of nests during the study period. As in the case of Oriental Darter highly significant increase in the total number of nests of Indian Shags was noted. It used to nest in 7 heronries. The estimated breeding population of Indian Shags in 2011 breeding season is 724, which is 2.41% of the South Asian Biogeographic population. Indian Pond-herons form one of the wide spread colonial nesting species of the study area; it nested in 14 heronries and did not show any significant increase in the nest number during the period of study. Wetland birds such as Great Cormorant *Phalacrocorax carbo*, Little Egret *Egretta garzetta*, Intermediate Egret *Egretta intermedia*, Great Egret *E. alba*, Purple Heron *Ardea purpurea*, Black-crowned Night-heron *Nycticorax nycticorax* and Black-headed Ibis *Threskiornis melanocephalus* were found to nest only in Kumarakom KTDC Tourist Complex Heronry. Among these species maximum number of nests belonged to Intermediate Egret and the least to Black-headed Ibis.

It was found that the nesting period of Oriental Darter starts in April and lasts up to November. Majority of the darter heronries are located within or close to private human habitation (42.86%). Clutch size varied from 2 to 6; majority of the nests (54%) had 4 eggs at the time of the observation. 66.13% was the calculated nesting success for Oriental Darter during the entire study period. Nesting success showed an increase from 2009 to 2011. In the initial year it was 40.28% and in 2010 and 2011 it was 59.71% and 85.62% respectively. Eleven species of trees were found used by Oriental Darters in seven heronries and out of these six are exotic and the rest are native species. *Artocarpus hirsutus, Acacia mangeum, Eucalyptus tereticornis* and *Hevea barsiliensis* formed 69% of the all nest trees. Trees with height 15-20m seem to be the most preferred by Darter in Kuttanad wetlands. 38% of the Darter pairs formed their own nesting colonies in a tree. 62% nested in trees with Little Cormorant and Indian Shags.

Darter nesting trees of various heronries showed a very significant variation. *Artocarpus hirsutus* was the most widely used nesting tree, which was grouped into two classes based on the number of nests, with less than 10 nests and more than 10 nests, and these were analyzed against height, GBH, canopy cover, ground cover, distance from the nearest path and distance from the nearest water body. None of the variables showed any significance with the grouped number of nests.

Shannon-Wiener Index, Simpson Index and species richness were calculated for various classes of vegetation found in the nesting and non nesting areas within each darter breeding sites. KTDC Tourist complex heronry showed high diversity and species richness in the case of herbs and trees. Among the 22 species of trees spotted in the quadrate studies, *Artocarpus hirsutus* showed high abundance (29.3%) followed by *Eucalyptus tereticornis*. But the *Hibiscus tiliaceus* (18.2%) was the most abundant tree species in the non nesting zones.

Oriental Darter showed almost stable feeding rate throughout the day with a slight decline in the noon hours. The feeding rate was found almost stable from June to September and a declining trend was noticed from October. Just like the feeding rate, successful feeding observations also showed a declining trend after September in both years of the study period.

Direct observation and the analysis of regurgitates showed that the Cyprinidae family species and *Stolephorus* spp. formed the dominant fish prey species. Direct observation at the foraging areas in the Vembanad Lake and various paddy fields showed that it preyed on 17 species of fishes and prawn/shrimp species. Based on the data generated by following the direct observation methods the mean length of prey fishes found to be eaten by Oriental Darter in Kuttanad wetlands is found to be 7.53±2.89cm with a range of 2.4 cm to 25.4cm. Species such as *Stolephorus* spp., *Amblypharyngodon melettinus, Puntius filamentosus, Puntius* spp., *Parambassis* spp., *Etroplus suratensis* are the most commonly preyed fishes. Samplings were done at ten selected sites using the cast net revealed the presence of 19 species of fishes and one invertebrate species prawn/shrimp). Chithira Kayal (site VII) showed high species diversity and least were at the last site north of the Thannermukkom saltwater barrage (site X) and no prey species were collected from site IX. But Pathiramanal Island (site VIII) showed high species richness. Richness was low at site north of the Thannermukkom saltwater barrage. *Stolephorus* spp. (58.6%) and *Parambassis* spp. (11.3%) were the most abundant fish species collected during the samplings. Collection of the regurgitated prey items at the various nesting sites yielded valuable information

on the food items which the adult used to feed the nestlings. A total of 65 individuals of 10 fish species and one prawn/shrimp species were collected from the below the nesting trees at South Police Station heronry. Relative frequencies of occurrence, weight and number of each species were calculated. *Stolephorus* spp. occurred in higher frequency (85.71%) and three species such as *Puntius vittatus, Barbodes subnasutsus* and Prawn/Shrimp spp. showed lower frequencies (14.29%). Mean length of fishes from the direct observations, samplings in the selected areas and sampling based on the regurgitations did not show any significant variation in mean length and weight.

A general baseline data on the direct and indirect factors which threaten the waterbirds and heronries of Kuttanad wetlands was generated and a conservation action plan has been proposed for the region. Landscape alteration, hunting, felling of nesting vegetation and roosting trees, overgrowth of exotic vegetation, pesticides, tourism related activities and predation and other kinds of mortalities are the major threats which are detrimental to the life of wetland birds and heronries of Kuttanad wetlands.